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ABSTRACT

Transitional situations, such as those experienced by work study students, may create cognitive difficulties by requiring people to simultaneously use both a learning and a use logic. To examine this phenomenon, a problem solving task (electrical schemata of a washing machine) was administered to 43 full time students and 51 work study students studying electricity. The schemata was administered before and after a 2-week on-the-job training program for work study students. Data analysis revealed five categories of errors. With regard to these categories, both full time and work study students presented roughly the same pattern of mistakes on the pretest. Comparison of pre- and post-test results, however, revealed that full time students showed a significant decrease in the number of mistakes made while the nature of the errors stayed the same between the two tests. Work study students maintained a constant number of mistakes between pre- and post-tests, but the nature of the errors changed. These results suggest that full time students experienced no disruption in the evolution of their mental representation while work study students experienced interference with the evolution in the learning logic and a change in mental representation. This change in mental representation might be seen as a first step in a cognitive process of integration of the learning and the use logics. (NRB)

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MENTAL REPRESENTATION AND PROBLEM SOLVING IN WORK STUDY STUDENTS.

This research was conducted in Paris at the Conservatoire National des Arts et Metiers. It was part of an assesment project supported by the French Ministery of Vocational Education to study the New Education Plan for young people (1983).

At present, analyses of the data are being conducted at Boston University, Department of Psychology, with Dr. Kathleen M. White.

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INTRODUCTION.

Our investigation focuses on the cognitive mechanisms used by people to adapt themselves to new circumstances. Often modifications of mental representation are involved in facing new situations, and cognitive mechanisms or processes are invoked to enable us to master the difficulties of a transitional situation.

To analyse these processes in this research, we chose a transitional situation in which young adults have to go from school to work and back from work to school .

One way to explain the difficulties created by such transitions and what happens for people during these transitions is to say that there are 2 logics: the learning and the use logics.
- The learning logic : refers to how we learn in school, and to the particular mental structuration we impose on our own academic knowledge. We refer to this mental structuration as a learning logic.
- The use logic : refers to more practical aspects of knowledge. In work situations, people impose another mental structuration on their knowledge; we refer to this mental structuration as a use logic.

For example, Sperandio relates an experiment with 3 groups of physicians -generalist, specialist and novice physicians. The 3

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groups received the same information about a sickness of the thyroid and were asked to translate their mental representation of the diseased thyroid by making a model with clay.

.Young physicians and generalist made the most academic models, like the one they learned at the university.These models looked like a normal thyroid.

.On the other hand, specialists made very important distortions in the models. These distortions emphasized and even exaggerated the sick part of the thyroid.

These models in fact provided a way of highlighting the relevant illness information.

This study gives us an example of what can be seen as two different logics: the learning logic and the use logic.

In our view, a transitional situation creates cognitive difficulties or even disruptions precisely because it asks people to make use simultaneously of 2 different logics.This is the notion we have been exploring in the work-study situation.

THEORETICAL BACKGROUND.

Based on previous research,we know that a cognitive disruption may occur immediately after a short on-the-job training period. In fact, comparing the performance on a problem solving task in 2 populations (work study students and full time students), our results show a significantly higher performance for the student full time students. No positive evolution in problem solving

performance was found in the experimental group (work study students) tested just before and immediately after an on-the-job training period.

A major concept underlies this research :

.Mental representation is conceived as a developing structure which is elaborated through the actions of people (Pylyshyn, Inhelder) and is characterized by processes of structuration and restructuration.When coping with new situations, we need to understand them, to manage them and to make sense out of them. To do this, we learn to use our knowledge in different and specific representational modes.

On a cognitive level, the first entrance into a work situation provides a process of transformation of mental representation : it is a process of "destructuration and restructuration" which is useful (even necessary) for bringing prior knowledge (school learning) into the work situation.

GENERAL HYPOTHESIS.

For our study,we designed a problem solving task--an electrical schematic of a washing machine-- and we administered it to a sample of young adults (18-21 years old) studying electricity in 2 different situations: a) in school full time (control group), and 2) part time in school and part time in a work program (experimental group).

With a written description of how a washing machine works, we asked subjects to complete the problem solving task: FIG 1. SHOW FIG 2 : the completed schema.

Our basic assumption was that rather than being a chance to acquire new knowledge, the on-the-job training period offered an opportunity to acquire a different structuration of knowlegde. Consequently, we analysed performance on this task before and after an on-the-job training period, hoping to find signs of integration between the learning and the use representational modes in work-study student populations.

METHOD.

The electrical schematic and mental representation.

The electrical schematic is not only a replication of an installation, but it includes another kind of information. In fact, it is possible and useful to write and read an electrical schematic without seeing the real installation.So, the electrical schematic can be seen as a symbolization of the mental processes used by electricians. The electrical schematic is like the architect's plan : it provide an overall structure but did not solve all the practical problem (Anderson,1980).

The electrical schematic of a washing machine:

Each subject received 2 sheets of paper:

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1. one with a written description of how a washing machine works.
2. the other is a presentation of all components : there are on a special place on the sheet of paper to make it easier to find the simple solution.

What do we ask to the subjects ? From the written description:

. he will locate the different components

. he will find the relations among them.

(slide to illustrate the most simple solution).

Work-study students have opportunities to try processes other than a reproduction of learning. Going into a transitional situation (work situation in this case) and coping with a use modeshould set up a somewhat different mobilization of their knowledge.So, we should see a new structuration of knowledge after the on-the-job training period. This means that different kind of element should come into view as errors of different nature, or different patterns of error characterising the different groups of young people.

SAMPLE.

We chose a sample of young adult people (18-21 years old) in specialisation in an electricity training program after the French degree BEP.

There were 2 subsamples:

-- the experimental group : composed of students who were part time at school and part time at work (n=51)
-- the control group (n=43) : composed of students who stayed in school full time.

For each subsample, we administrated the electrical schematic (washing machine) twice:
--before a training period : to asses the structuration of knowledge at a particular point in time
--after the training period: (or an equivalent interval for the control group) to provide data relevant to the question :"have cognitive attainments being modified,or restructured?".

WHAT DID WE HOPE TO FIND?

To understand performance chances in both the experimental and control group, we analysed the nature of the errors made in solving the problem.
For this analysis, the forty different kinds of mistakes related to the 12 items necessary to solve the problem were grouped into 5 categories. To understand these 5 categories, we have to know that each item necessary to solve the problem is symbolized by a line which joined 2 electrical components. So, different kinf of mistakes appear in these jonctions between 2 electrical component and they defined the 5 categories of errors:

. I. incomplete relationship

. II. miscellaneous errors

.III. incorrect connections

. IV. miscarried connections

. V. no relationship.

In the incomplete relationship : the line starts correctly on one component but stops without reaching the other onr (or any other one).

In the miscellaneous errors, the incorrect connections and the miscarried connections, the subject drew a line which joined 2 electrical components, BUT :

in the miscellaneous errors : various kind of mistakes appear with a low frequency

in the incorrect connections: specific mistakes appear frequently on specific components

in the miscarried connections : the connection is false but reflected a part of the reflexion necessary to draw the right answer.

The category V, no relationship, means that no line joined the 2 electrical components.

We expected that:

(1) On test 1, when the frequencies of mistakes within the 5 categories were analyzed, the experimental and the control group will be similar.

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(2) Between the test 1 and the test 2 we expected that:

--for the control group, the mistakes would by of the same nature (even if there were few errors over all)

--for the experimental group, the on-the-job training period because it involved new information processing, would involve changes in the nature of the mistakes.

RESULTS.

(1). With regard to the 5 categories of mistakes, both control and experimental group presented the same pattern of mistakes on test 1 on 4 of the 5 categories. As a consequence, the control and the experimental group are considered as roughly similar.

(2). within the control and the experimental group, the nature of errors showed a different evolution between test 1 and test 2:

--In the control group: the results show a significant decrease in the number of mistakes within 4 of the 5 categories (I,II,IV, V) .

So, with fewer mistakes on the second test, the nature of the errors stays the same between the 2 tests.

Category III (incorrect connections) showed no significant evolution.

--In the experimental group: From test 1 to test 2, the number of mistakes is more or less the same, and 2 categories of mistakes showed a significant evolution.

Within category V (no relationship), the number of mistakes decreased from test 1 to test 2,
BUT within category III (incorrect connections),the number of mistakes increased from test 1 to test 2.
The 3 others categories (I,II,IV) showed no significant change in performance,or evolution.

In the experimental group, with a constant number of absolute mistakes, the nature of the errors change between the first and the second test.

DISCUSSION.

Previous results suggest that people in a school-work situation are not able to take an easy advantage of their activities in a training period. This might be the case because the on-the-job training period was too short (2 weeks) to permit a process of destructuration and restructuration to take place. Nevertheless, a destructuration occured (in the experimental sample), which suggested a cognitive disruption.

What about evolutions in mental representation?

In the control group, the significant differences appear between test 1 and test 2, due to a decrease in the number of mistakes (in 4 of the 5 categories of errors).
In the control group, the learning logic prevailed continually. The structuration of mental representation evolved continually in the same logic (as reflected by the decrease in the number of

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mistakes across the 5 categories). These full time students experienced no disruption in the evolution of their mental representation, so that they improved thier problem solving performance on the test 2 by decreasing the number of mistakes in the different categories.

Now, what about the mental representation in the experimental group in this situation of cognitive disruption?

With a more or less constant number of mistakes from the test 1 to the test 2, the subjects abandoned one category (no relationship) to develop another one (incorrect connections).The modifications in the number of the errors showed clearly that the structuration of mental representation has changed.

The change in the nature of the errors occured consequently to an on-the-job training period. This on-the-job training period seems to interfered with the evolution in the learniong logic.We interpret this interference as a reflection of some changes (evolution?) in Mental Representation : it is no longer the same information which appears to be chosen to solve the problem, or to try to solve the problem.

The changes in the structuration of Mental Representation might be seen as a process of destructuration of the learning logic. In fact, the initial mental structuration no longer fits with the requirements encountered in the work situation: having lost its usefulness, the initial mental structuration seems to become

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questionable. Not immediately adaptable in the work situation, the mental structuration evolves. The process of evolution is reflected in the changing nature of the mistakes: abandoning one category (no relationhip) to develop another one (incorrect connections).

Furthermore, this change or evolution in mental representation might be seen as a first step in a cognitive process of integration of the learning and the use logic. This first step could be defined as a process of destructuration of Mental Representation in the learning logic and should prceeded more slow cognitive processes involved in the integration of theoretical knowledge and practical experience.

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Table 1 : Comparison of experimental and control groups in the number of mistakes made on test 1.

Categories of errors	Number of mistakes: Experimental group (n=51)	Number of mistakes: Control group (n=43)	Test of difference between the two groups - χ^2 -	
Incomplete relationship	14	15	.51	
Miscellaneous errors	35	29	.005	
Incorrect connections	88	76	.02	
Miscarried connections	83	106	9.40	**
No relationship	90	92	2.33	

** significant p<.01

Table 2 : Comparison of experimental and control groups in changes between test 1 and test 2 in each of the five categories of errors.

Categories of errors	Changes in the number of mistakes					
	Experimental group			Control group		
	test 1	test 2	test of difference - χ^2 -	test 1	test 2	test of difference - χ^2 -
Incomplete relationship	14	10	.70	15	6	5.50 *
Miscellaneous errors	35	24	2.18	29	13	6.42 **
Incorrect connections	88	122	6.80 **	76	87	.91
Miscarried connections	83	65	2.56	106	41	34.60 ***
No relationship	90	64	5.59 *	92	51	15.05 ***

*** significant $p < .001$
** significant $p < .01$
* significant $p < .02$

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